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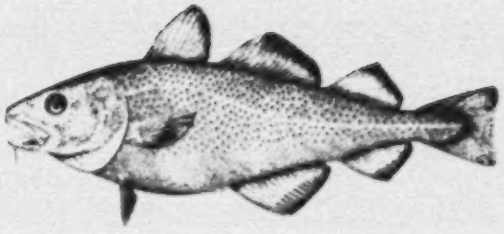
Canadian Science Advisory Secretariat
Newfoundland and Labrador Region | Science Response 2015/018

NORTHERN (NAFO DIVS. 2J3KL) COD STOCK UPDATE



Cod (Gadus morhua)

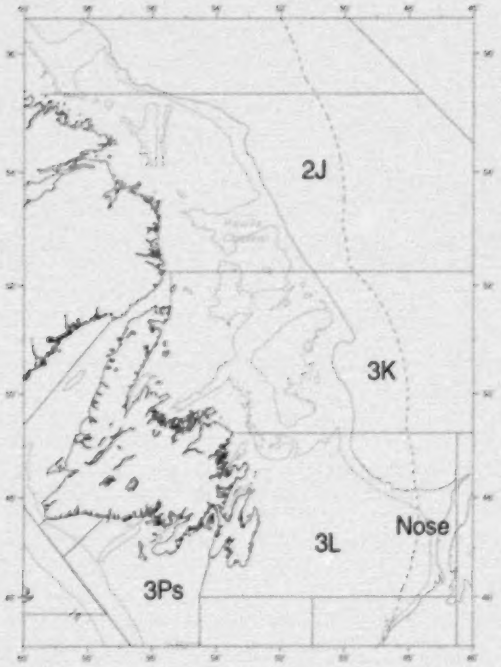


Figure 1: Stock area of Northern (Divs. 2J3KL) cod. The dashed line indicates Canada's 200 nautical mile Exclusive Economic Zone (EEZ).

Context

A conservation limit reference point (LRP) was established for Northern cod in 2010 (DFO 2010) and is defined as the average spawning stock biomass (SSB) during the 1980s. This reference point defines the boundary between the critical and cautious zones within the Precautionary Approach (PA) framework (DFO 2009) and defines the stock level below which serious harm is occurring. The most recent full assessment (March, 2013) concluded that the spawning stock biomass (SSB) in 2012 was 15% of the LRP. A subsequent stock update (March 2014) with additional data from 2013 indicated the three-year average (2011-13) SSB at that time was 18% of the LRP; at these levels the stock is considered to have suffered serious harm and the ability to produce good recruitment is seriously impaired. The scientific advice from the most recent full assessment (DFO 2013) and subsequent stock update (DFO 2014) stated that removals should be kept low to promote stock growth. There are no explicit timelines or targets for stock rebuilding upon which to base advice, but a rebuilding plan for this stock is currently under development.

The Northern cod stock has been subjected to ongoing stewardship and recreational fisheries in the inshore since 2006. The current multi-year management plan for the stewardship fishery,

Canada

whereby each harvester is permitted an annual allowance of 2.3 t (=5,000 lb.), is scheduled to remain in place until March 31, 2016. In 2014, recreational fishers were permitted a maximum catch of 15 fish per boat per day over a 5 week period.

The purpose of this Science Response is to update stock status based on new information obtained during 2014. This Science Response Report (SRR) results from the Science Response Process of March 18, 2015 on the Northern Cod (Div. 2J3KL) Stock Update. The meeting reviewed information from:

(1) the DFO autumn research vessel (RV) survey (specifically: indices of abundance, biomass, spawning stock biomass (SSB), recruitment, and trends in mortality rates);

(2) the inshore sentinel catch rate index; and

(3) fishery exploitation rates based on tagging.

Analysis and Response

Reported landings

A stewardship fishery for cod and a recreational fishery for groundfish were permitted in the inshore during 2014. Reported landings in 2014 were 4,583 t. The 2014 landings comprised 4,290 t in the stewardship fishery, 275 t in the sentinel surveys, and 18 t taken as by-catch. Catches outside the Canadian EEZ (200 mile limit, Fig. 1) during 2014 are not yet available, but have generally been <300 t during the past 5 years. Recent history of reported landings is summarized in Appendix Table 1.

There are no requirements to report recreational landings. However, information from tagging (see below) indicates that recreational landings are substantial and that total removals are much higher than reported landings.

Stock Trends

Bottom-trawl surveys

The abundance and biomass indices from the autumn DFO RV surveys have been low since the start of the moratorium in 1992 (Figs. 2 and 3). The abundance index increased during 2005-09 and the biomass index increased during 2005-08; these increasing trends did not persist during 2009-11, but have resumed during 2012-14. Most of the abundance (81%) and biomass (76%) is located in the northern portion of the stock area (Divs. 2J and 3K). The recent (2012-14) upward trend in the abundance index is mostly due to increased numbers of small cod (≤ age 3).

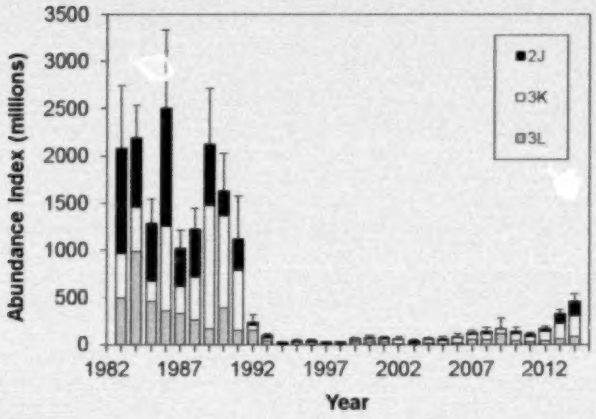


Figure 2: Offshore abundance index (+2 SE's) from autumn RV surveys in Divs. 2J3KL.

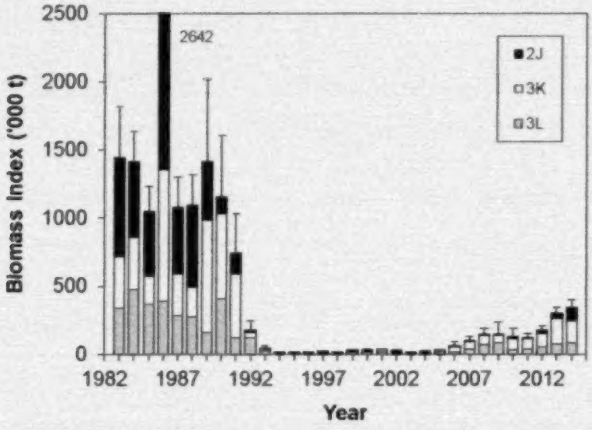


Figure 3: Offshore biomass index (+2 SE's) from autumn RV surveys in Divs. 2J3KL.

The three-year averages (2012-14) for the abundance and biomass indices are 18% and 19%, respectively, of the average during the 1980s. Annual values for these indices are summarized (by the Northwest Atlantic Fisheries Organization [NAFO] Division) in Appendix Table 2.

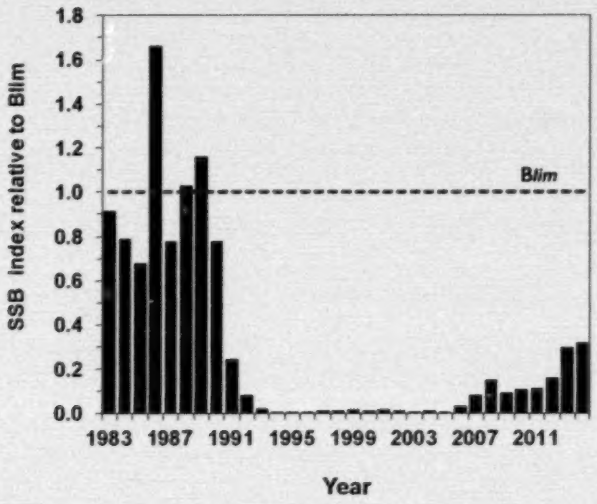


Figure 4: SSB index from autumn DFO RV surveys in Divs. 2J3KL. The dashed line is the Limit Reference Point (Blim) which is defined as the average SSB during the 1980s.

The SSB index from the autumn DFO RV survey declined rapidly in the late 1980s and early 1990s and remained very low for over a decade after the 1992 moratorium. After 2005 the SSB index shows an upward trend (Fig. 4). With the inclusion of the most recent information, the three-year average SSB index increased from 19% of the LRP in 2011-13 to 26% in 2012-14, and although improving, remains in the critical zone.

Information on recruitment (ages 3-4) and mortality is derived from mean catch rate at age during the autumn DFO RV surveys.

Recruitment in the offshore in the 1990s and 2000s has been poor compared to the 1980s (Fig. 5). The number of recruits in the autumn DFO RV survey in the 1990s has consistently been much lower than during the 1980s, but improved slightly in year-classes from 2002 onwards. The 2011 year-class in the 2014 survey is the strongest observed at age 3 in the post-moratorium period. The numbers of this year-class at age 3 in 2014 correspond to about one third of the average numbers of age 3s observed in year-classes of the 1980s.

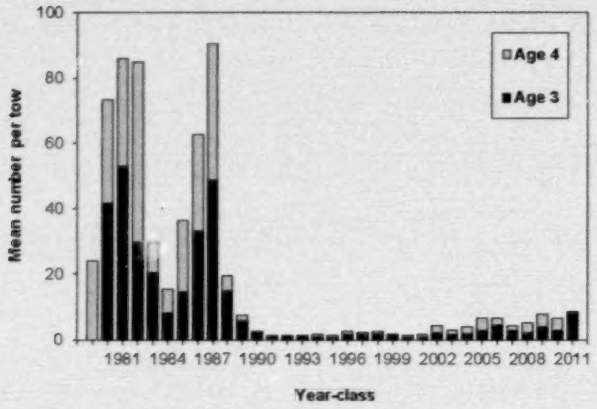


Figure 5: Abundance of the 1979-2011 year-classes at age 3 and/or age 4 in the offshore of Divs. 2J3KL from the autumn RV surveys.

Recent recruitment has improved, but is not expected to result in major changes to SSB relative to the LRP in 2015.

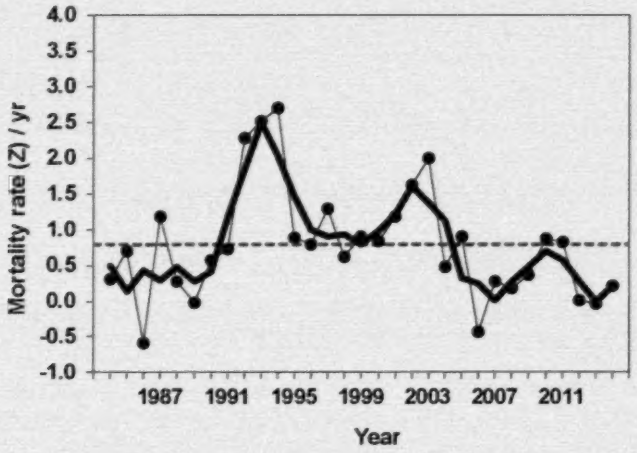


Figure 6: Total mortality rate (Z) of cod aged 4-6 calculated using data from the autumn RV surveys in the offshore of Divs. 2J3KL. For example, the value in 1996 is the mortality experienced by the 1991-1989 year-classes from ages 4-6 in 1995 to ages 5-7 in 1996. The dashed line is the time-series average (Z=0.79 which corresponds to 55% mortality per year). The thick solid line is the 3-yr running mean.

The total mortality rate (Z, ages 4-6) was low in the 1980s, but was at a high level (Z>0.6, i.e., >45% per year) from the early 1990s to the mid-2000s, with peaks during the early 1990s and early 2000s (Fig. 6). This high level of mortality during much of the post-moratorium period has been a major impediment to stock recovery. Total mortality shows a general decline after 2003, except during 2010 and 2011. The three-year average mortality rate during 2012-14 was 0.06 which corresponds to only 6% mortality per year. In recent (2011-13) surveys, several cohorts have shown increasing numbers among older ages which is not biologically possible. This indicates that one or more of the 2011-13 surveys, and the three-year average Z for 2012-14, may be influenced by year effects.

Sentinel Catch Rates - Inshore

The inshore was divided into three areas for the analysis of sentinel catch rate data:

(1) a northern area (2J and northern 3K);

(2) a central area (southern 3K and northern 3L); and

(3) a southern area (southern 3L) that is partly dependent on migrant fish from 3Ps and possibly other offshore areas.

The dividing lines for these areas are Partridge Point at the western side of Notre Dame Bay and Grates Point at the eastern side of Trinity Bay (Fig. 7).

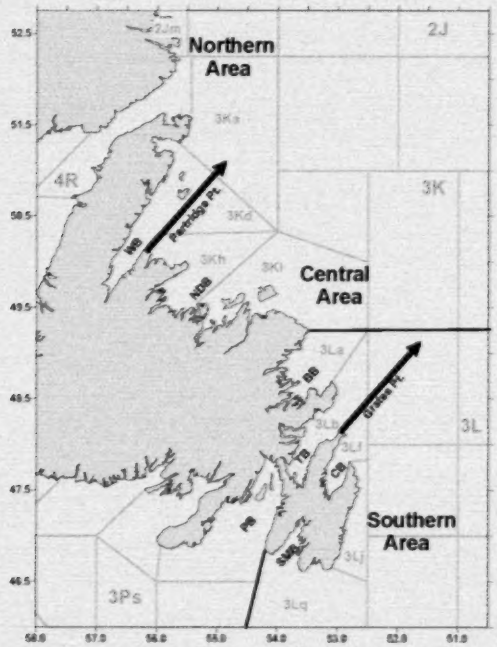


Figure 7: Eastern Newfoundland indicating the locations of the inshore northern, inshore central and inshore southern areas. Major bays are indicated: White Bay (WB), Notre Dame Bay (NDB), Bonavista Bay (BB), Trinity Bay (TB), Conception Bay (CB), and St. Mary's Bay (SMB); Placentia Bay (PB) is in Subdiv. 3Ps. Grey lines delimit boundaries of statistical unit areas (i.e., 3Ka, 3Kd, etc.).

Sentinel survey mean catch rates are preliminary as ageing of samples from the 2014 sentinel fishery was not complete. Catch rates increased in the northern and central areas during 2012-14. Catch rates are well above the respective time series (1995-2014) average in the northern and central areas, but close to average in the southern area (Fig. 8). Recent catch rates are much lower in the southern area compared with the northern and central areas.

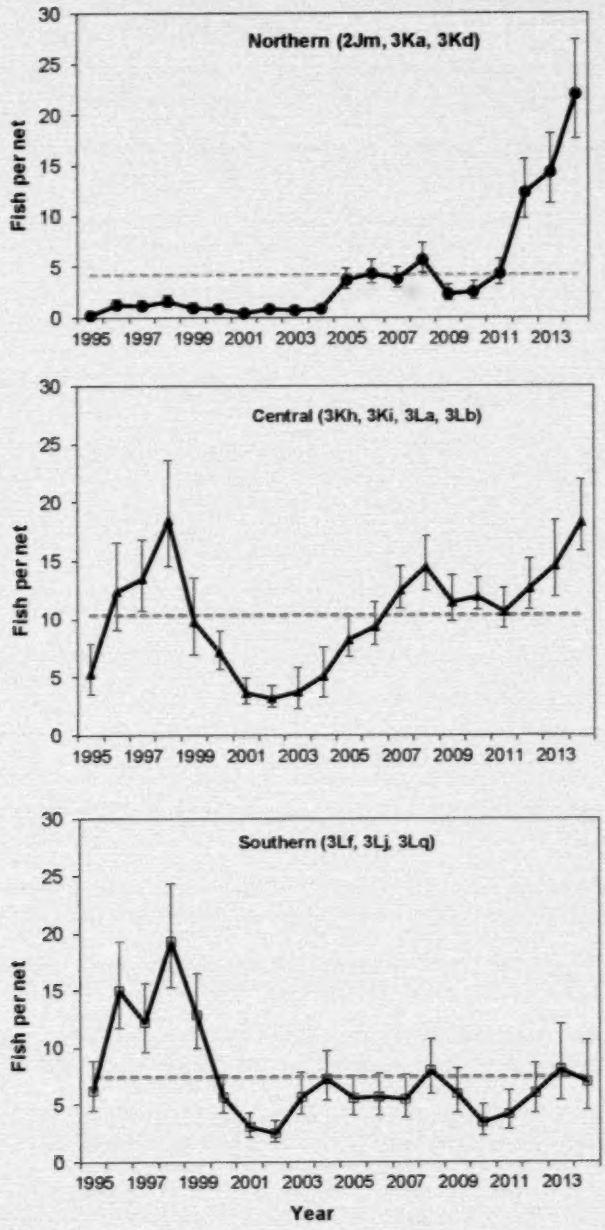


Figure 8: Trends in gillnet (5½ inch mesh) standardized mean catch rate indices from sentinel surveys for each of the three inshore areas depicted in Fig. 7. Dashed lines indicate time-series average catch rates for each area.

Indices from the autumn DFO survey and the Sentinel survey were generally higher in 2014, particularly in the north (Divs. 2J and 3K), indicating improvement in overall stock status.

Tagging

Information from recaptures of cod tagged in various inshore regions of 2J during 2013-14 and 3KL during 1997-2014 was used to estimate average annual exploitation (harvest) rates. No cod

were tagged in the offshore during 2009-14, but most inshore tagging was conducted during July-October when migrant offshore cod would be inshore.

Tagging results indicate that exploitation levels continued to be low (≤ 5%) in 2014, for cod tagged in northern, central, and southern areas. These estimates incorporate assumed values for the annual rate of natural mortality (0.2 in 3L and 0.4 in 2J and 3K) and are based on tagged cod in the 50-85 cm length range at release; these cod would be well selected by commercial gears.

The reporting rate for tags (commercial and recreational combined) during 1997-2014 averaged 0.67; the value for 2014 was 57% which is the lowest in the time series. Harvesters should return all tags because low reporting rates can add uncertainty to the estimates of exploitation rates and the analyses of movement patterns and stock structure.

During 2014 recreational fishers returned more tags (54%) than commercial fishers (46%), after numbers were adjusted by respective tag reporting rates. The percentage of the total tags returned by recreational fishers has been high (average 39%, range 26% to 54%) during the past 7 years (2007-14). This indicates that recreational landings are substantial and that total removals are much higher than reported landings.

Conclusions

- Indices from the autumn DFO RV survey and the Sentinel survey were generally higher in 2014, particularly in the north (Divs. 2J and 3K), indicating improvement in overall stock status.
- Recent recruitment has improved, but is not expected to result in major changes to SSB relative to the LRP in 2015.
- Tagging results indicated that exploitation levels continued to be low (≤ 5%) in 2014.
- The SSB from the autumn DFO RV survey increased from 19% of the LRP in 2011-13 to 26% in 2012-14, and although improving, remains in the critical zone.
- To be in accordance with the DFO Precautionary Approach framework, management actions must promote stock growth and removals from all sources must be kept to the lowest possible level until the stock has cleared the critical zone.

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Sources of information

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Appendices

Table 1: Reported landings in NAFO Divs. 2J3KL by management year (nearest thousand metric tons). Detailed catch history is reported in Brattey et al. 2010.

Year	62-76 Avg.	77-91 Avg.	98	99	00/01	01/02	02/03	03-06 Avg.	06/07 & 07/08[1,2]	08/09[1,2]	09/10 to 12/13[1,2]	13/14 & 14/15[1,2]
TAC	N/A	N/A	4	9	7	6	6	0	-	-	-	-
Can. Fixed	88	90	5	9	5	7	4	1	3	4	4	5
Can. Mobile	9	84	-	-	-	-	-	-	-	-	-	-
Others	405	38	-	-	-	-	-	-	-	-	-	-
Totals	502	212	5	9	5	7	4	1	3	4	4	5

[1] There was no TAC in the last eight years, but fishers were permitted an allowance per license holder of 3,000 lb in 2006/07, 2,500 lb in 2007/08, 3,250 lb in 2008/09, 3,750 lb in 2009/10 to 2012/13, and 5,000 lb in 2013/14 and 2014/15.

[2] Does not include Canadian recreational fisheries landings or non-Canadian landings.

Table 2: Cod abundance (000's), biomass (t) and spawning stock biomass (SSB, t) indices from DFO autumn RV surveys (1992 onwards). Values for years prior to 1992 are reported in Brattey et al. 2010.

Year	2J Abundance	3K Abundance	3L Abundance	Total Abundance	2J Biomass	3K Biomass	3L Biomass	Total Biomass	Total SSB* (t)
1992	30,960	61,622	147,158	239,740	12,795	35,344	126,323	174,462	47,909
1993	16,989	36,907	36,813	90,709	5,129	14,227	24,596	43,952	9,561
1994	8,145	9,361	4,291	21,797	2,693	4,241	2,874	9,808	2,578
1995	12,346	23,387	7,733	43,466	2,312	4,578	5,115	12,005	3,050
1996	13,625	18,518	7,066	39,209	4,261	5,457	6,140	15,858	3,057
1997	6,936	8,827	9,859	25,623	3,609	3,978	8,991	16,578	4,502
1998	6,669	15,612	6,454	28,735	4,483	7,280	4,804	16,567	4,865
1999	6,074	29,308	25,281	60,664	2,527	12,230	13,611	28,368	6,643
2000	7,516	35,774	29,010	72,299	3,082	11,994	15,070	30,146	4,885
2001	7,033	28,535	27,724	63,292	2,646	9,890	18,706	31,242	7,378
2002	9,534	41,853	10,984	62,371	3,680	11,889	7,460	23,029	3,388
2003	9,316	19,906	13,638	42,860	3,065	4,912	4,849	12,826	3,065
2004	9,503	34,468	18,605	62,576	4,921	9,609	5,266	19,796	3,475
2005	18,519	33,834	8,780	61,133	5,719	16,696	5,118	27,533	2,662
2006	11,739	52,285	18,711	82,735	6,818	38,009	16,982	61,809	17,517
2007	26,656	54,600	47,248	128,504	8,755	58,427	35,722	102,904	48,818
2008	24,439	62,848	53,958	141,246	10,281	71,329	66,401	148,011	89,065
2009	15,250	47,949	111,782	174,981	6,473	51,106	85,410	142,989	53,578
2010	17,278	83,060	39,013	139,351	9,905	89,388	29,255	128,548	63,051
2011	17,937	59,233	29,204	106,374	8,542	71,541	41,615	121,698	65,546
2012	26,108	101,579	39,584	167,270	21,900	101,579	50,985	185,169	96,748
2013	97,136	170,174	58,344	325,654	37,986	181,106	78,927	298,019	177,218
2014	163,877	210,793	88,706	463,376	94,457	166,597	82,471	343,525	188,288

* Note that the estimates of SSB for recent years may be revised because the proportions mature at age are estimated each year and can change for unfinished cohorts that are used in calculation of SSB.

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